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REPORT OF PROJECT NR TF-958

COUNTERMEASURES EVALUATION OF RECEIVER R-695/1LT-6B (U)

/MJD

PREPARED JOINTLY BY:

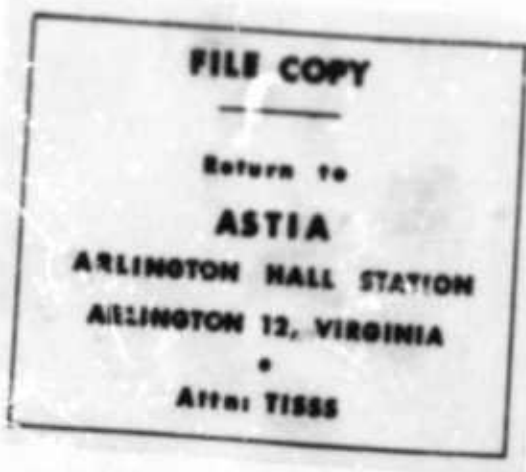
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HEADQUARTERS
UNITED STATES CONTINENTAL ARMY COMMAND
Fort Monroe, Virginia

ATDEV-5 413.4/26(S)(24 Feb 59)

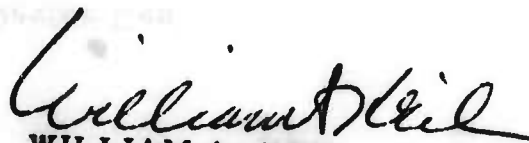
24 February 1959

SUBJECT: Report of Project Nr TF-958, Countermeasures Evaluation
of Receiver R-695/ALT-6B (U)

TO: Chief of Research and Development
Department of the Army
Washington 25, DC

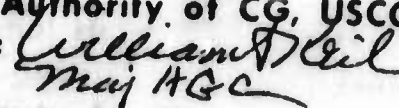
1. Inclosed is a copy of the Joint Report of US Army Air Defense Board and Wright Air Development Center, Project Nr TF-958, subject: "Countermeasures Evaluation of Receiver R-695/ALT-6B (U)."
2. This headquarters concurs in the conclusions of paragraph 7 of the report.
3. It is recommended that this report be brought to the attention of responsible technical agencies for their information in the design of future radar tracking equipment.

FOR THE COMMANDER:



WILLIAM A. KEIL
Major, AGC
Asst Adjutant General

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REPORT OF PROJECT NR TF-958

COUNTERMEASURES EVALUATION OF RECEIVER R-695/ALT-6B (U)

/MJB

ABSTRACT:

(C) THIS FINAL REPORT OF TEST CONTAINS AN EVALUATION OF THE R-695/ALT-6B AUTOMATIC AIRBORNE RECEIVER DESIGNED TO INTERCEPT GROUND AND AIRBORNE SIGNALS, ACTIVATE AND TUNE THE AN/ALT-6B JAMMING TRANSMITTER TO THE PROPER FREQUENCY. TEST DATA WERE OBTAINED FROM THE NIKE AJAX FIRE CONTROL SYSTEM, TRACKING PORTION ONLY. THE RECEIVER WAS EVALUATED IN TERMS OF EFFECTIVE RANGE AND ACCURACY OF FREQUENCY SET-ON.

TEST OFFICERS:

US ARMY AIR DEFENSE BOARD
WADC, WCLGL-2

CAPT C. M. KINDICK
MR. T. G. CUNNINGHAM

1. (U) AUTHORITY.

A. TEST DIRECTIVES.

(1) LETTER, ATDEV-5 413.4/114(C), (23 JUL 58) HEADQUARTERS, UNITED STATES CONTINENTAL ARMY COMMAND, 23 JUL 58, SUBJECT: "JOINT EVALUATION OF RADAR COUNTERMEASURES SET, AIRBORNE JAMMER AN/ALT-6B (U)."

(2) ECM TESTING CONFERENCE OF 30 OCTOBER 1956 BETWEEN ARDC AND CONARC.

B. PURPOSE. TO EVALUATE THE FOLLOWING:

(1) THE EFFECTIVENESS OF THE R-695/ALT-6B RECEIVER AGAINST X-BAND TRACKING RADAR.

(2) THE VULNERABILITY OF X-BAND TRACKING RADAR TO JAMMING AND TO DEVELOP OPERATIONAL TECHNIQUES TO MINIMIZE THESE COUNTERMEASURES.

2. (U) REFERENCES.

A. ANNUAL JOINT ELECTRONIC COUNTERMEASURES PLANNING CONFERENCE, HELD AT USCONARC, 29 OCTOBER 1957.

B. TELEPHONE CONVERSATION BETWEEN LT COL GEMMELL, US ARMY AIR DEFENSE BOARD, AND MR. LACO KNIGHT OF WADC, ON 5 MAY 1958.

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3. (C) DESCRIPTION OF MATERIEL.

A. ECM EQUIPMENT.

(1) COUNTERMEASURES TRANSMITTING SET AN/ALT-6B IS A CONTINUOUS WAVE, NOISE AND FREQUENCY MODULATED, REMOTELY CONTROLLED, AIRBORNE RADAR JAMMING SYSTEM TUNABLE OVER A FREQUENCY RANGE OF 40 TO 10,500 MEGACYCLES. EFFECTIVE FREQUENCY COVERAGE OF THE EQUIPMENT IS DETERMINED BY THE SELECTION OF INTERCHANGEABLE TRANSMITTER GROUPS FOR INSTALLATION IN THE TRANSMITTING SET. EACH TRANSMITTER GROUP COVERS A SPECIFIC FREQUENCY RANGE AND CAN BE OPERATED WITH EITHER OF THE TRANSMITTERS. TWELVE DIFFERENT TRANSMITTER GROUPS ARE USED TO COVER THESE FREQUENCIES, EACH INCLUDING A TUNABLE MAGNETRON OSCILLATOR CAPABLE OF JAMMING A DIFFERENT RANGE OF FREQUENCIES. THIS OSCILLATOR HAS AN RF POWER OUTPUT OF 150 WATTS MINIMUM AT ANY POINT IN THE FREQUENCY RANGE OF THE OSCILLATOR. THE MODULATION AMPLITUDE IS SUCH THAT THE BANDWIDTH OF THE TRANSMITTER SIGNAL IS A MINIMUM OF EIGHT MEGACYCLES. THIS BANDWIDTH HAS AT LEAST 100 WATTS CONCENTRATED THEREIN AND NOT LESS THAN EIGHT WATTS IN ANY ONE MEGACYCLE PORTION OF THIS BAND. THE SYSTEM AS USED IN THESE TESTS IS DESIGNED TO JAM X-BAND DEFENSIVE SEARCH, TRACK AND GUNLaying TYPE RADARS WITHIN THE FREQUENCY RANGE OF 8750 TO 10,500 MEGACYCLES.

(2) MODES OF OPERATION. THE TRANSMITTING SET AN/ALT-6B IS CAPABLE OF FOUR MODES OF OPERATION. FREQUENCY SWEEP GENERATORS AND/OR A RANDOM NOISE MODULATION SIGNAL ARE USED IN THE DIFFERENT MODES OF OPERATION.

(A) SPOT JAMMING. CONTINUOUS JAMMING OF A SINGLE FREQUENCY.

(B) SLOW-SWEEP JAMMING. PROVIDES THE CAPABILITY TO SWEEP A BANDWIDTH ADJUSTABLE FROM APPROXIMATELY ZERO TO THE ENTIRE FREQUENCY RANGE OF THE OSCILLATOR TUBE. THE SWEEP RATE IS VARIABLE FROM 2 TO 120 CYCLES PER MINUTE.

(C) FAST-SWEEP JAMMING. PROVIDES THE CAPABILITY TO FAST-SWEEP ABOUT A CENTER FREQUENCY. THE BANDWIDTH THAT MAY BE FAST SWEEPED WILL VARY ACCORDING TO THE FREQUENCY RANGE OF THE OSCILLATOR TUBE USED. THE X-BAND OSCILLATOR THAT WILL BE USED IN THESE TESTS MAY BE FAST SWEEPED OVER A BANDWIDTH VARIABLE FROM APPROXIMATELY 0 TO 200 MEGACYCLES. THE SWEEP RATE IS VARIABLE OVER THE GIVEN BANDWIDTH AT ANY DESIRED RATE FROM 2 TO 20 CYCLES PER SECOND.

(D) COMBINED-SWEEP JAMMING. THIS JAMMING MODE USES A COMBINATION OF SLOW AND FAST SWEEPS DESCRIBED IN (B) AND (C), ABOVE. WHEN

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COMBINED SWEEP JAMMING IS USED, THE CENTER FREQUENCY IS SELECTED FOR SLOW SWEEP JAMMING AND THE FAST SWEEP JAMMING SIGNAL MODULATES THE VARYING SLOW SWEEP FREQUENCY.

B. AUTOMATIC RECEIVER. THE AUTOMATIC RECEIVER EQUIPMENT, WHEN EMPLOYED AS PART OF THE AN/ALT-6B, WILL CONTINUOUSLY MONITOR SIGNALS WITHIN A PRESET RANGE OF FREQUENCIES AND WILL TURN ON THE TRANSMITTING EQUIPMENT WHEN A DANGEROUS SIGNAL, AS DETERMINED BY PRESET CONTROLS AND ANALYSIS CIRCUITS, IS RECEIVED. THE AUTOMATIC RECEIVER EQUIPMENT CAN BE SET TO RESPOND TO THE PARTICULAR SIGNALS DETERMINED TO BE DANGEROUS TO THE AIRCRAFT MISSION. AFTER THE TRANSMITTING EQUIPMENT HAS BEEN TURNED ON, THE AUTOMATIC RECEIVER EQUIPMENT WILL BRIEFLY DISABLE THE TRANSMITTER AT RANDOM TIMES, AND LOOK THROUGH THE JAMMING SIGNAL TO DETERMINE IF THE VICTIM SIGNAL IS STILL PRESENT. WHEN THE VICTIM SIGNAL HAS DISAPPEARED IT WILL TURN OFF THE TRANSMITTING EQUIPMENT AND RESUME ITS MONITOR FUNCTIONS.

C. FREQUENCY. EFFECTIVE FREQUENCY COVERAGE OF THE AN/ALT-6B IS DETERMINED BY SELECTION OF MATCHED INTERCHANGEABLE TRANSMITTER AND RECEIVER GROUPS FOR INSTALLATION IN THE BASIC TRANSMITTING AND RECEIVING EQUIPMENT. EACH PAIR OF GROUPS COVER A SPECIFIC FREQUENCY RANGE. TWO RECEIVER GROUPS ARE PRESENTLY AVAILABLE AND HENCE THE MONITOR FUNCTION OF THE AN/ALT-6B AUTOMATIC RECEIVER EQUIPMENT CAN BE USED ONLY IN THESE FREQUENCY RANGES. (S-BAND 2350-3600 MCs. X-BAND 8750-10,500 MCs.)

D. MODES OF RECEIVER OPERATION. TWO MODES OF AUTOMATIC RECEIVER OPERATION ARE AVAILABLE. THE MODE IS SELECTED PRIOR TO TAKE-OFF AND THE CONTROLS SET ACCORDINGLY. THE MODES ARE:

(1) MODE A. IN THIS MODE A SELECTED RANGE OF FREQUENCIES IS MONITORED ON A 100% PROBABILITY OF INTERCEPT BASIS. THE CENTER OF THE BAND MAY BE POSITIONED TO ANY FREQUENCY WITHIN THE TUNING RANGE OF THE RECEIVER GROUP. BANDWIDTH OF THE MONITORED CHANNEL MAY BE 200 MC, 150 MC, 100 MC OR 50 MC. A SIGNAL FALLING WITHIN THE SELECTED BANDWIDTH AND DISPLAYING THE CHARACTERISTICS DETERMINED TO BE DANGEROUS WILL TURN ON THE TRANSMITTING EQUIPMENT. SWEEP RATE, CENTER FREQUENCY AND BANDWIDTH ARE PRESET.

(2) MODE B. IN MODE B ANY BAND OF FREQUENCIES WITHIN THE LIMITS OF THE RECEIVER GROUP WILL BE SCANNED. ON RECEIVING A SIGNAL HAVING THE CHARACTERISTICS DETERMINED TO BE DANGEROUS, THE RECEIVER WILL STOP SCANNING AND POSITION THE JAMMER WITHIN ± 20 MC OF THE TARGET SIGNAL. SWEEP RATES AND BANDWIDTH ARE PRESET.

E. SIGNAL DISCRIMINATION.

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(1) SEARCH. PULSED SEARCH AND TRACK. RECEIVER IS SENSITIVE TO SIGNALS HAVING PULSE REPETITION FREQUENCIES IN THE RANGE OF 200 TO 10,000 PPS.

(2) TRACK. PULSED TRACK. RECEIVER IS SENSITIVE TO PULSED SIGNALS HAVING REPETITION FREQUENCIES IN THE RANGE 800 TO 10,000 PPS. SYSTEM IS INOPERATIVE FOR CW, NOISE OR PULSED SIGNALS PRF LESS THAN 800 PPS OR MORE THAN 10,000 PPS.

(3) CW. RECEIVER IS SENSITIVE TO CW SIGNALS ONLY. AUTOMATIC SYSTEM WILL NOT BE ACTIVATED ON ANY PULSED-TYPE SIGNALS.

F. TRANSMITTER JAMMING MODES (AFTER RECEIVER LOCK-ON).

(1) FAST SWEEP (RECEIVER MODES A OR B) 2-20 CPS
0-200 MC BANDWIDTH

(2) SLOW SWEEP (RECEIVER MODES A OR B) 2-120 CPM
0-FULL BANDWIDTH

(3) COMBINED SWEEP (RECEIVER MODES A OR B) ANY COMBINATION OF FAST AND SLOW SWEEP.

G. EQUIPMENT INSTALLED IN AIRCRAFT. TWO EACH COUNTERMEASURES TRANSMITTING SETS AN/ALT-6B WITH TWO EACH RECEIVERS R-695/ALT-6B WERE INSTALLED IN A C-131B TYPE AIRCRAFT. TWO HORN TYPE ANTENNAS AT-581/ALT-6B WERE INSTALLED IN A RADOME ON THE UNDERSIDE OF THE AIRCRAFT POINTING FORWARD, TILTED 20 DEGREES DOWN FROM HORIZONTAL. A SINGLE ANTENNA WAS USED FOR TRANSMITTING AND RECEIVING.

H. RADAR SUPPORT EQUIPMENT. DETAILED DESCRIPTIONS OF THE NIKE AJAX SYSTEM CAN BE FOUND IN DEPARTMENT OF THE ARMY TECHNICAL MANUALS 9-5000 SERIES.

4. (S) BACKGROUND. THE COUNTERMEASURES TRANSMITTING SET AN/ALT-6B IS THE RESULT OF A SECOND SOURCE CONTRACT TO IMPROVE THE PERFORMANCE, OPERATIONAL CAPABILITY AND FREQUENCY RANGE OF ITS PRECEDENT EQUIPMENT AN/APT-16. THE AN/APT-16 EQUIPMENT WAS DESIGNED AS A SPOT JAMMER TO COVER THE S-BAND FREQUENCY ONLY. THE AN/ALT-6B EQUIPMENT WILL COVER THE FREQUENCY RANGE FROM 40 TO 10,500 MEGACYCLES USING PLUG-IN OSCILLATOR. THIS EQUIPMENT WILL PROVIDE FOUR DIFFERENT MODES OF OPERATION AGAINST EITHER VERTICALLY OR HORIZONTALLY POLARIZED ANTENNAS. WITH THE INCREASED SPEED OF AIRCRAFT, INCREASE IN THE NUMBER OF JAMMING EQUIPMENTS INSTALLED AND THE DECREASE OF SPACE AVAILABLE FOR AN ECM OPERATOR, IT WAS APPARENT THAT SOME AUTOMATIC DEVICE WAS

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NEEDED TO OPERATE THE JAMMING EQUIPMENT. THE RECEIVER R-695/ALT-6B IS THE RESULT OF A CONTRACT TO PROVIDE A RECEIVER THAT WOULD SEARCH THE FREQUENCY SPECTRUM, INTERCEPT A VICTIM SIGNAL AND AUTOMATICALLY TUNE THE TRANSMITTER TO THAT FREQUENCY AND START JAMMING.

5. (S) SUMMARY OF TEST.

A. A TOTAL OF FIVE FLIGHTS WERE FLOWN, OF WHICH TWO WERE CONSIDERED SUCCESSFUL. OF THE REMAINING THREE, TWO WERE UNSUCCESSFUL BECAUSE OF ERRATIC OPERATION OR FAILURE OF THE AN/ALT-6B AUTOMATIC EQUIPMENT AND ONE BECAUSE OF FAILURE OF THE AIRCRAFT POWER POD.

B. THE TEST WAS CONDUCTED IN TWO PHASES. PHASE IA WAS TO DETERMINE THE OPTIMUM SWEEP RATES AND WIDTHS FOR THE JAMMER AGAINST THE TRACK RADAR SO THAT AN EVALUATION OF THE AUTOMATIC RECEIVER AND THE COUNTER-COUNTERMEASURES TECHNIQUES OF THE TRACK RADAR WOULD BE REALISTIC. PHASE IB WAS THEN CONDUCTED USING PARAMETERS ESTABLISHED IN PHASE IA AND DATA RECORDED IN THE FORM OF AN EVENTS RECORDER TAPE. DURING THIS PHASE ONLY ONE MISSION WAS SUCCESSFUL AND THE POWER POD FAILURE NECESSITATED THE RETURN OF THE TEST AIRCRAFT TO ITS BASE AND CANCELLATION OF FURTHER TESTING.

C. THE TARGET AIRCRAFT, CARRYING THE AN/ALT-6B AUTOMATIC EQUIPMENT, FLEW RADIAL INBOUND COURSES TO THE RADAR SITE AND ALL RUNS WERE STARTED AT A RANGE OF 40,000 YARDS. THE TRACK RADAR WAS LIMITED TO A FREQUENCY RANGE OF 9400 TO 9600 MC AND WAS OPERATED IN BOTH AUTOMATIC AND MANUAL AIDED TRACKING MODES. TEST RESULTS INDICATE THAT THE JAMMING AFFECTED THE TRACK RADAR IN AUTOMATIC MODE BUT HAD VERY LITTLE EFFECT IN MANUAL AIDED MODE. THE AUTOMATIC RECEIVER WAS TURNED ON AT 40,000 YARDS AND THE AVERAGE TIME FOR TURN-ON AND ACTIVATION OF THE TRANSMITTER WAS APPROXIMATELY 50 SECONDS. THIS WAS AVERAGE TIME WITH A SINGLE ANTENNA INSTALLATION. MINIMUM TIME WAS 12 SECONDS AND MAXIMUM TIME 120 SECONDS. FREQUENCY SET-ON ACCURACY OF THE RECEIVER WAS WELL WITHIN THE SPECIFICATION OF ± 20 MC DURING THE ONE MISSION IN PHASE IA.

6. (S) DISCUSSION.

A. CONSIDERABLE DIFFICULTY WITH THE OPERATIONAL RELIABILITY OF THE R-695/ALT-6B RECEIVER WAS ENCOUNTERED. AT NO TIME WERE BOTH OF THE SYSTEMS OPERATIONAL AND CONTRACTOR PERSONNEL DEVOTED A GREAT AMOUNT OF TIME TO THE MAINTENANCE OF THE RECEIVER FOR PROPER OPERATION.

B. BECAUSE OF THE AIRCRAFT POWER POD FAILURE AND PRIOR COMMITMENTS OF THE US ARMY AIR DEFENSE BOARD, THE TEST WAS TERMINATED AND NO COUNTER-COUNTERMEASURES TECHNIQUES WERE INVESTIGATED BY THE GROUND RADAR. COUNTER-COUNTERMEASURES WERE NOT PERMITTED DURING PHASES I AND II. THESE WERE TO BE INVESTIGATED DURING A THIRD PHASE WHICH WAS NEVER FLOWN.

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7. (S) CONCLUSIONS.

A. THE R-695/ALT-6B RECEIVER OPERATED SATISFACTORILY DURING THIS TEST AS FAR AS IT PROGRESSED.

B. RELIABILITY AND MAINTENANCE OF THE R-695/ALT-6B RECEIVER ARE MAJOR PROBLEMS.

C. NO CONCLUSIONS CAN BE DRAWN AS TO THE EFFECTIVENESS OF THE COUNTER-COUNTERMEASURE TECHNIQUES BECAUSE THE TEST DID NOT PROGRESS TO THIS PHASE.

8. (U) PERSONNEL. PARTICIPANTS IN THE CONDUCT OF THIS TEST WERE:

US ARMY AIR DEFENSE BOARD:

LT COL J. D. GENMELL
MAJOR T. E. MARRIOTT
CAPT C. M. KINDICK (TEST DIRECTOR)

WRIGHT AIR DEVELOPMENT CENTER:

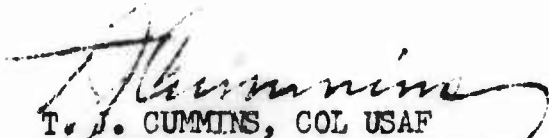
CAPT ROBERT K. YECK
T. G. CUNNINGHAM (TEST DIRECTOR)

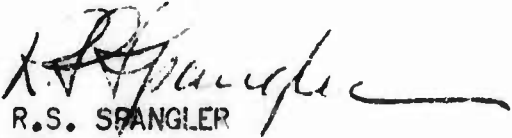
THIS REPORT WAS PREPARED BY CAPT C. M. KINDICK, US ARMY AIR DEFENSE BOARD, CAPT ROBERT K. YECK AND MR. T. G. CUNNINGHAM, WRIGHT AIR DEVELOPMENT CENTER.

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T. J. CUMMINS, COL USAF
Chief, Weapons Guidance Laboratory
Directorate of Laboratories


R. S. SPANGLER
COLONEL, ARTY
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US ARMY AIR DEFENSE BOARD

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